University of California at Berkeley
Physics 129A
Professor Freedman
Fall 2004
September 19, 2004
Homework #3 (Due: Friday September 24)

1. Using the angular momentum latter operators J_+ and J_- construct a table of angular momentum coupling constants appropriate for combining angular momentum $J_1 = 1$ with angular momentum $J_2 = 1$, to get the $J = J_1 + J_2$ representations. You may note that there are ambiguities in the phase of the coefficients but you should be able to compare your results with the table on the PDG web site (http://pdg.lbl.gov/).

2. The Hamiltonian for an axial symmetric rotator is

$$H = \frac{L_x^2 + L_y^2}{2I_1} + \frac{L_z^2}{2I_3}$$

(a) What are the eigenvalues of H?
(b) Sketch the spectrum, assuming that $I_1 > I_3$.
(c) What is the spectrum in the limit that I_1 is much larger than I_3?

3. A Λ-hyper nucleus is one in which a neutron is replaced by a bound Λ-hyperon. ${}^4He_\Lambda$ and ${}^4H_\Lambda$ is a doublet of mirror hyper nuclei. Deduce the ratio of the reaction rates

$$K^- + {}^4He \rightarrow {}^4He_\Lambda + \pi^-$$

$$\rightarrow {}^4H_\Lambda + \pi^o$$

4. (from Problem 4.32 Griffiths) The Σ^{*0} can decay into $\Sigma^+ + \pi^-$, $\Sigma^0 + \pi^0$, or $\Sigma^- + \pi^0$. Explain why the probability for the also possible decay to $\Lambda + \pi^0$, is much lower. Neglecting the $\Lambda + \pi^0$ mode how many decays to each of the other three modes would you expect if you observed a total of 100 disintegrations? In order to test your prediction you must compare to a real experimental data and consider statistics. What is the one standard deviation error for each mode with an experiment that observes a total 100 disintegrations. Extra credit: Find and discuss a paper on this experiment.